

It's not hard to realize that hurricane season is upon us again with the number and ferocity of storm activity seen recently on the Texas gulf coast. Hurricane season began June 1 and extends through Nov. 1. JSC has entered a state of continual preparedness in anticipation of the final storm season of this century. The JSC Hurricane Ride-out Team is preparing for the worst while hoping for the best. The Hurricane and Severe Weather Plan at JSC lists the guidelines that direct the preparations for a storm.

Action Level 4

Action Level 4 begins when a storm poses a threat to JSC within 72 hours. "This is typically when the storm enters the Gulf of Mexico," said Dennis Perrin, JSC's hurricane planning manager. Members of the hurricane team are required to review the plan to ensure that JSC will have a full stock of emergency supplies to ride out a storm if needed. JSC's Bill Roeh, chief of the Center Operations Directorate Project Management Office, is captain of the Hurricane Ride-out Team and has primary responsibility for preparing the center when severe storms threaten.

The Spaceflight Meteorology Group follows the storm using weather satellite imagery and other data and interprets the bulletins issued by the National Hurricane Center. The forecasters advise the JSC senior staff and the Hurricane Ride-out Team throughout the storm threat period. "At this point we ask supervisors to allow employees with special considerations such as small children to use the liberal leave policy in order to evacuate their families," Perrin said.

Riding Out the Storm

JSC prepares for the worst, hopes for the best

Supervisors and managers also should review project priorities and assignments during Level 4 to assure operations can be reduced or terminated before storm conditions pose a threat to the center.

Action Level 3

Action Level 3 goes into effect when a hurricane could threaten JSC/Ellington Field within 48 hours. At the direction of the Center Operations Director, Bill Parsons, the Hurricane Ride-out Team moves to the Emergency Operations Center in Bldg. 30L to set up a command center. Each organization has a designated emergency planning representative and an alternate who stay informed of the status of the action levels during a hurricane. "When a storm is 48 hours out from JSC, we encourage supervisors to allow all employees to use the liberal leave policy and we encourage employees to take it," Perrin noted.

Action Level 2

Level 2 is initiated by authorization of the center director when the threat to JSC is within 36 hours from landfall. "At Level 2, we look for JSC Director George Abbey to release employees and close the center," Perrin said. "The only people left on site are the Ride-out Team," he added. Prior to closing the center, employees will be asked to secure their offices. "An important part of preparing the center for closing

because of a hurricane threat is securing offices, a responsibility that falls on every employee," JSC Emergency Preparedness Manager Bob Gaffney said.

These preparations include protecting computers, raising blinds, securing classified materials, and closing all doors. The emergency planning representatives in each organization are kept informed on the status of the action levels during the alert and will coordinate information concerning shutdown activities and work assignments for their area.

Fourteen Area Protection Teams from the Plant Engineering Division check buildings and roofs, picks up loose objects outside, secure possible hazards and make preparations to shut down site utilities. "The main thrust should be on preparation – those things that all employees can do to mitigate the effects of a storm or minimize the degree of damage they can do," Roeh said. "Preparation is the key to successful recovery; we'll recover regardless, but our recovery will be faster if we prepare adequately in advance." The Hurricane Ride-out Team completes all protective measures that will place the center in a final state of preparedness. The Ride-out Team continues to secure the center up to the point the weather becomes unsafe.

Action Level 1

Action Level 1 is initiated by the center director and goes into effect when gale-

force winds arrive at the center, making it too dangerous to continue outside activities. The Ride-out Team gathers at its post and waits for the storm to subside. During the storm, activities are limited to only essential emergency repairs that can be performed without placing the health and safety of the assigned personnel at risk.

Immediately after the storm, the Ride-out Team moves back into action, assessing the damage and arranging for necessary repairs. "We have a Damage Assessment Plan and Damage Assessment Teams that survey the damage and evaluate the buildings for safety," Perrin said. "The Damage Assessment Teams report to the Hurricane Ride-out Team captain. Their evaluations help determine when it's safe for employees to return to work and what buildings are brought on line first," Perrin added.

In the event of an evacuation, employees can continue to stay in contact with the center through the use of the two emergency information phone numbers listed below. Public Affairs notifies employees when to return to work through the Employee Information Service, x36765, and broadcasts by local radio and television reports.

For hurricane information on the Internet, employees may access <http://shuttle.nasa.gov/weather/>.

Q&A

Questions and answers about hurricanes from the JSC Spaceflight Meteorology Group

What is the difference between a tropical disturbance, a tropical depression, tropical storm and a hurricane?

A tropical disturbance is a discrete system of organized showers and thunderstorms that originates in the tropics and maintains its identity for 24 hours or more.

A tropical depression is an organized system of clouds and thunderstorms with a defined counter-clockwise circulation with maximum sustained winds of 38 mph or less.

A tropical storm is an organized system of strong thunderstorms with a defined circulation and maximum sustained winds of 39 to 73 mph.

A hurricane is an intense tropical weather system with a well-defined circulation and sustained winds of 74 mph or greater.

How is a hurricane formed?

Hurricanes start as a cluster of showers and thunderstorms over tropical waters. A hurricane's main sources of energy are heat and moisture. Developing hurricanes gather this energy through contact with warm ocean waters. Water temperatures of 80 degrees Fahrenheit or warmer are typically needed for storm development.

Wind patterns are critical for tropical storm formation. The pattern most conducive to tropical storm formation is when low-level winds, below 5,000 feet, are converging, and upper-level winds, above 25,000 feet, are light and diverging. Upper-level winds that are too strong will greatly inhibit tropical storm development, and often cause a hurricane or tropical storm to weaken.

What are the different parts of the hurricane?

The typical hurricane has two or three and sometimes more outer convective bands, also called feeder bands. These bands are comprised of cells resembling ordinary thunderstorms and can be up to 300 miles from the eye. The outer convective bands are generally 40 to 80 miles apart and come in advance of the main rain shield.

The rain shield is a solid area of rain that typically becomes heavier closer to the eye. The outer edge is well-defined and its distance from the eye varies greatly from storm to storm.

Spiral bands or convective rings are regions of active showers and thunderstorms that encircle

the centers of hurricanes. They are prevalent in the more intense hurricanes and curve cyclonically inward toward the center of the storm where they appear to merge to form the eye wall.

The eye wall is an organized band of thunderstorms that immediately surrounds the center or eye of a hurricane. It typically contains the fiercest winds and most intense rainfall.

The eye is a relatively calm center of the hurricane. The winds are light, and skies may be partly cloudy or even clear. The average hurricane eye diameter is a little more than 20 miles. In general, when the eye is shrinking in size, the hurricane is intensifying. After the eye's passage, the violent wind blows in the opposite direction to what it was right before the eye moved over an area and the heavy rain returns.

What is a storm surge?

A storm surge is a large dome of water often 50 to 100 miles wide that sweeps across the coastline near where a hurricane makes landfall. Storm surge can range from four to six feet for a minimal hurricane to greater than 20 feet for the stronger ones. The stronger the hurricane and the shallower the offshore water, the higher the surge will be. This can cause severe flooding in coastal areas, especially when the storm surge coincides with normal high tides. Water weighs about 1,700 pounds per cubic yard; extended pounding by frequent waves can demolish any structures not specifically designed to withstand such forces. Along the immediate coast, storm surge is the greater

threat to life and property, even more so than the high winds.

Hurricane Camille produced a 25-foot storm surge in Mississippi. Hurricane Hugo in 1989 generated a 20-foot storm tide in South Carolina. Hurricane Andrew in 1992 caused a 17-foot storm surge in southeast Florida.

Note, the elevation of JSC ranges from 15 to 23 feet, so a 20 foot storm surge could put the lowest elevations at JSC under five feet of water.

How much rainfall and flooding can a hurricane produce?

Hurricanes, tropical storms, and tropical depressions are capable of producing abundant amounts of flood-producing rainfall. During landfall, a hurricane rainfall of 6 to 12 inches is common. If the storm is large and mov-

ing slowly, greater amounts of rainfall can be expected. To estimate the potential rainfall amount (in inches), divide the storm's forward motion into 100. For example, a storm moving five miles per hour could produce 20 inches of rain.

What kind of damage can happen from the wind of a hurricane?

As winds increase, pressure against objects is added at a disproportionate rate. Pressure force against a wall increases with the square of wind speed; a threefold increase in windspeed gives a ninefold increase in pressure. A 25 mph wind causes about 1.6 pounds of pressure per square foot, and places 50 pounds of force on a four by eight sheet of plywood. In 75 mph winds, that force becomes 450 pounds, and in 125 mph, it becomes 1,250 pounds.

What about tornadoes?

Hurricanes also produce tornadoes, which add to the hurricane's destructive power. Typically, the more intense a hurricane is, the greater the tornado threat. When a hurricane brings its winds inland, the fast-moving air hits terrain and structures, causing increased low level wind convergence due to friction. This, in turn, enhances atmospheric lifting which increases the threat of tornadoes. The greatest concentration of tornadoes occurs in the right front quadrant of the hurricane.

Who issues hurricane watches and warnings?

Hurricane watches, warnings and advisories are officially issued by the National Weather Service's National Hurricane Center in Coral Gables, Fla. Meteorologists at NHC specialize in hurricane and tropical storm forecasting. They continually monitor atmospheric and ocean conditions, evaluate an array of atmospheric computer models and issue watches, warnings and advisories on tropical storms and hurricanes. The Houston/Galveston National Weather Service Office in League City customizes tropical storm and hurricane watches and warnings for southeast Texas. The Spaceflight Meteorology Group further customizes watches, warnings and advisories for JSC management and emergency planning managers.

How accurate are hurricane forecasts?

The National Weather Service's National Hurricane Center in Miami, Fla., prepares the official hurricane watches, warnings and advisories for the U. S. and adjacent ocean areas. Major advances have been made in hurricane forecast accuracy during the past 25 years due to improved satellite imagery and more sophisticated computer models. The average 72-hour forecast position error is about 300 miles, and the average 24-hour forecast position error is about 100 miles. This distance can mean the difference between destructive winds and storm surges and merely "tropical storm" conditions. Hurricane intensity changes are quite difficult to predict and the best plan is to expect the worst. A good rule of thumb is to plan for a storm arriving one category stronger and 12 hours sooner than predicted.